



US Army Corps
of Engineers®
Norfolk District



MONROE COUNTY
FLORIDA

FLORIDA KEYS COASTAL STORM RISK MANAGEMENT FEASIBILITY STUDY

Susan Layton
Chief, Planning and Policy Branch
Norfolk District
U.S. Army Corps of Engineers



An aerial photograph of a coastal area. In the foreground, a long, multi-lane bridge spans across the water. Beyond the bridge, there's a small, low-lying island with some buildings and vegetation. The water is a vibrant turquoise color, and there are some white wakes from boats in the water. The sky is a clear, deep blue.

PURPOSE OF PRESENTATION

The purpose of this presentation is to provide details and receive feedback on the Tentatively Selected Plan for the Florida Keys Coastal Storm Risk Management Study. The study just recently passed the Tentatively Selected Plan milestone and a Draft Feasibility Report with Integrated Environmental Impact Statement is currently scheduled for release in late May 2020.

AGENDA

An aerial photograph of a tropical coastline. A long, multi-lane bridge spans the bottom of the frame. Above the bridge, the water transitions from a deep blue to a vibrant turquoise. A small, crescent-shaped island with a sandy beach and palm trees is visible in the middle ground. Several small boats are scattered in the water, and a larger boat leaves a white wake in the foreground.

Study Timeline

Study Purpose

Overview of Analysis

Measures Considered

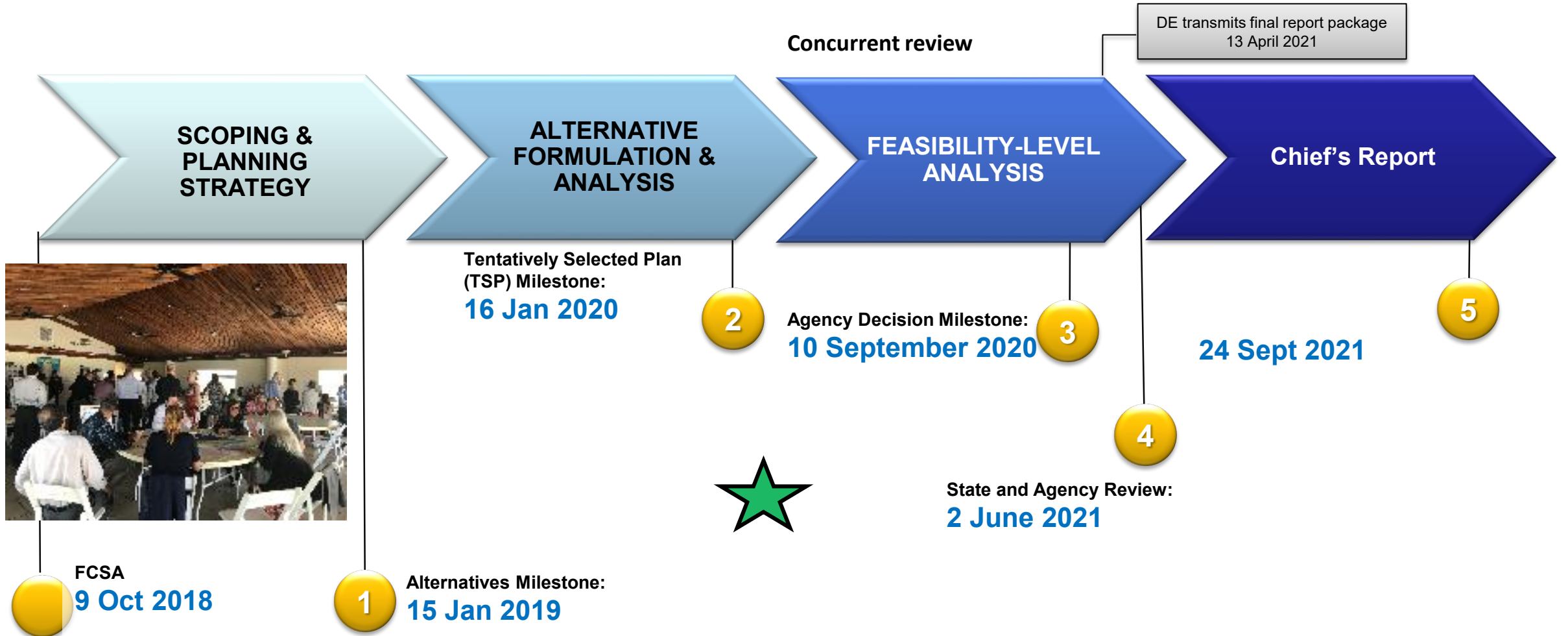
Alternatives

Recommendation

Next Steps

Questions?

SMART Feasibility Study Process: Florida Keys CSRM




STUDY PURPOSE AND SCOPE



- ❑ The Florida Keys Coastal Storm Risk Management Study is investigating solutions that will improve resiliency by reducing damage and risk from impacts of coastal storms taking into account sea level rise.
- ❑ The study area includes the entire Florida Keys including all municipalities.
- ❑ An Environmental Impact Statement is being prepared.

WHO IS ON THE TEAM?

An aerial photograph of a tropical island with a long bridge extending from the foreground. The water is a vibrant blue-green, and the island has lush green vegetation and a few buildings. A small boat is visible in the water near the bridge.

U.S. Army Corps of Engineers Project Delivery Team Members:

- Engineers
 - Civil
 - Coastal
 - Geotechnical
 - Cost
 - Project Manager
 - Planners
 - Biologists
 - Archaeologists
 - Economists
 - Real Estate Specialists
 - Attorneys
 - Geospatial (GIS) Specialists

Non-Federal Sponsor:

- Monroe County

Green = NEPA Cooperating Agency

Other stakeholders:

- Florida Department of Transportation
- U.S. Environmental Protection Agency
- National Oceanographic and Atmospheric Administration (NOAA), Protected Resources Division
- NOAA Florida Keys National Marine Sanctuary
- U.S. Fish and Wildlife Service
- U.S. Coast Guard
- Federal Emergency Management Agency (participating)
- National Park Service, South Florida Ecosystem Office
- Florida Department of Environmental Protection
- U.S. Naval Air Station Key West
- Federal Highways Administration

WHAT MEASURES WERE CONSIDERED?

An aerial photograph of a coastal area. In the foreground, a long, multi-lane bridge spans across the water. To the left of the bridge, there is a small island with some buildings and a parking lot. Further out, another smaller island is visible. The water is a deep blue-green color, and a small boat is seen moving across it, leaving a white wake. The sky is a clear, bright blue.

The following measures make up the suite of alternatives:

- **Structural Measures:** reduce magnitude of water level and/or probability of flooding in an area to reduce damage to structures in that area of reduced risk
- **Nonstructural Measures:** reduce damage to a specific structure and/or its contents, focus is on reducing the consequences of flooding on that structure instead of reducing the amount or probability of flooding
- **Natural and Nature Based Features (NNBF):** some natural features (ex. mangroves) reduce wave energy and/or storm surge when implemented alone or in conjunction with structural or nonstructural measures

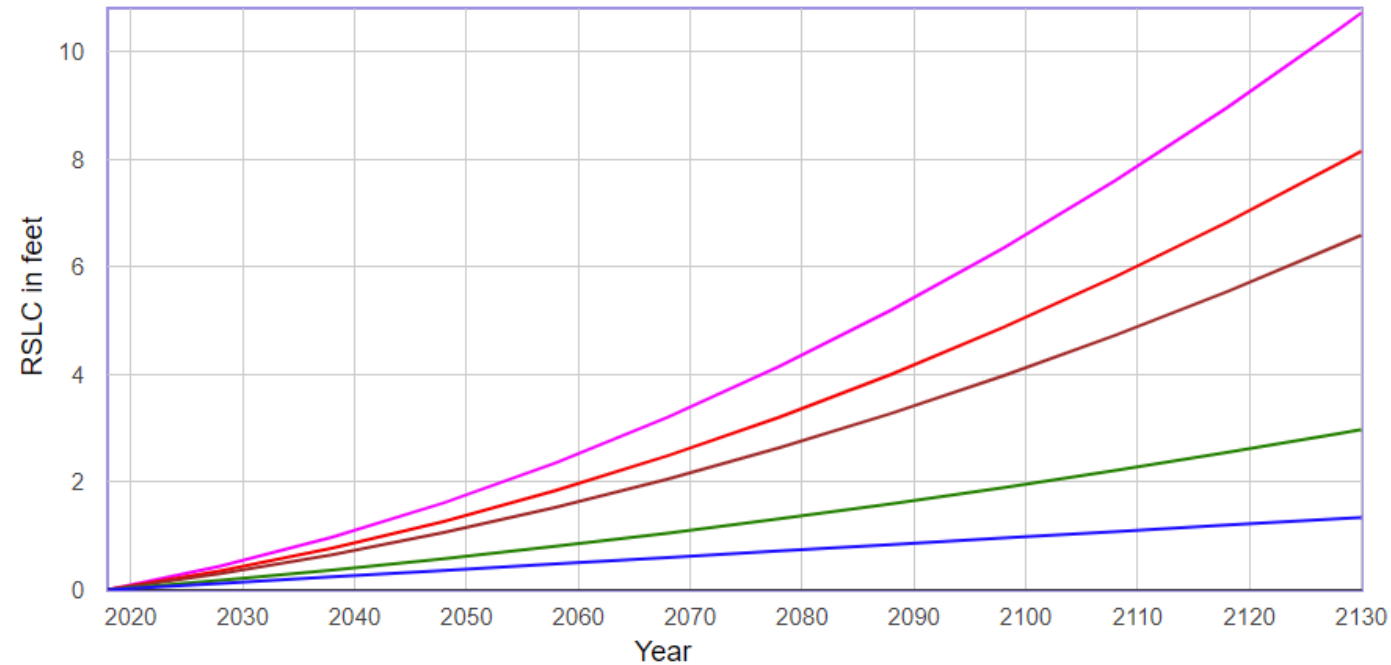
HOW WERE MEASURES EVALUATED?

An aerial photograph of a coastal area. In the foreground, a long, multi-lane bridge spans across the water. To the left of the bridge, there is a small island with some buildings and a parking lot. Further out, another smaller island is visible. The water is a deep blue-green color, and a boat is seen moving across it, leaving a white wake. The sky is a clear, bright blue.

- Detailed structure damage assessment
- GIS layers to support the selection of natural and nature based features (mangrove and submerged aquatic vegetation sites) from environmental resource agencies
- Input from Florida Keys National Marine Sanctuary and other resource agencies, identification of environmental impacts
- Input from Florida Department of Transportation
- Engineering analysis on applicability of structural measures in the study area
- Detailed costs for measures based on design refinements and identification of additional costs such as real estate and environmental mitigation
- Economics model: Generation 2 Coastal Risk Model (G2CRM)
- 50 year project horizon with a forecast storm suite including Sea Level Rise

SEA LEVEL RISE PROJECTION: USACE HIGH CURVE

Estimated Relative Sea Level Change Projections From 2018 To 2130 - Gauge: 8723970, Vaca Key, FL



- Reviewed SE Florida Climate compact guidance
- USACE sea level change curve calculator – NOAA gage 8723970, at Vaca Key, FL, is the nearest compliant gage
- USACE High curve used to formulate the plan
- Will also analyze USACE low and intermediate and NOAA high curves

NOAA High Rate
USACE High Rate
NOAA Int High Rate
USACE Int, NOAA Int Low
USACE/NOAA Low Rate

Projected SLR Increase (ft) 2018 to 2080 using 2018 sea level trend of 0.01200787 ft/yr

USACE Low	0.74
USACE Intermediate	1.37
USACE High	3.37
NOAA High	4.36

STRUCTURAL MEASURES SCREENING

Screened out:

- ✗ **Breakwaters:** high environmental impacts and costs compared to shoreline stabilization
- ✗ **Canal Improvements:** not able to provide significant damage reduction
- ✗ **Sea Walls:** engineering limitations and high cost due to topography and geology – lack of high ground to tie into
- ✗ **Floodwalls:** engineering limitations and high cost due to topography and geology – lack of high ground to tie into
- ✗ **Levees:** engineering limitations and high cost due to topography and geology – lack of high ground to tie into
- ✗ **Small Scale Ring Walls:** geologic constraints would require T-walls which are not cost effective
- ✗ **Storm Surge Barriers:** lack of high ground for surge barrier tie-in
- ✗ **Beachfill/Dunes:** extremely high cost due to distant sand sources (\$76/cubic yard)

Carried Forward:

- ✓ **Shoreline Stabilization along US 1:** rock revetment designed to reduce damage, especially erosion/washout, to the roadway



NONSTRUCTURAL MEASURES SCREENING

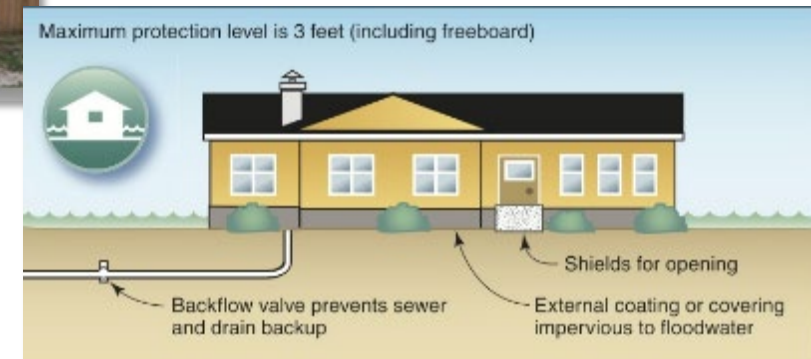
Carried Forward:

- ✓ Elevation
- ✓ Floodproofing
- ✓ Buyout/acquisition
- ✓ Warning systems
- ✓ Emergency Planning
- ✓ Land use Planning

- All nonstructural measures were carried forward to be included in the array of alternatives
- Geologic/technical limitations on the applicability of many structural measures in this area results in a reliance on nonstructural measures to reduce risk to structures in vulnerable areas



Home Elevation



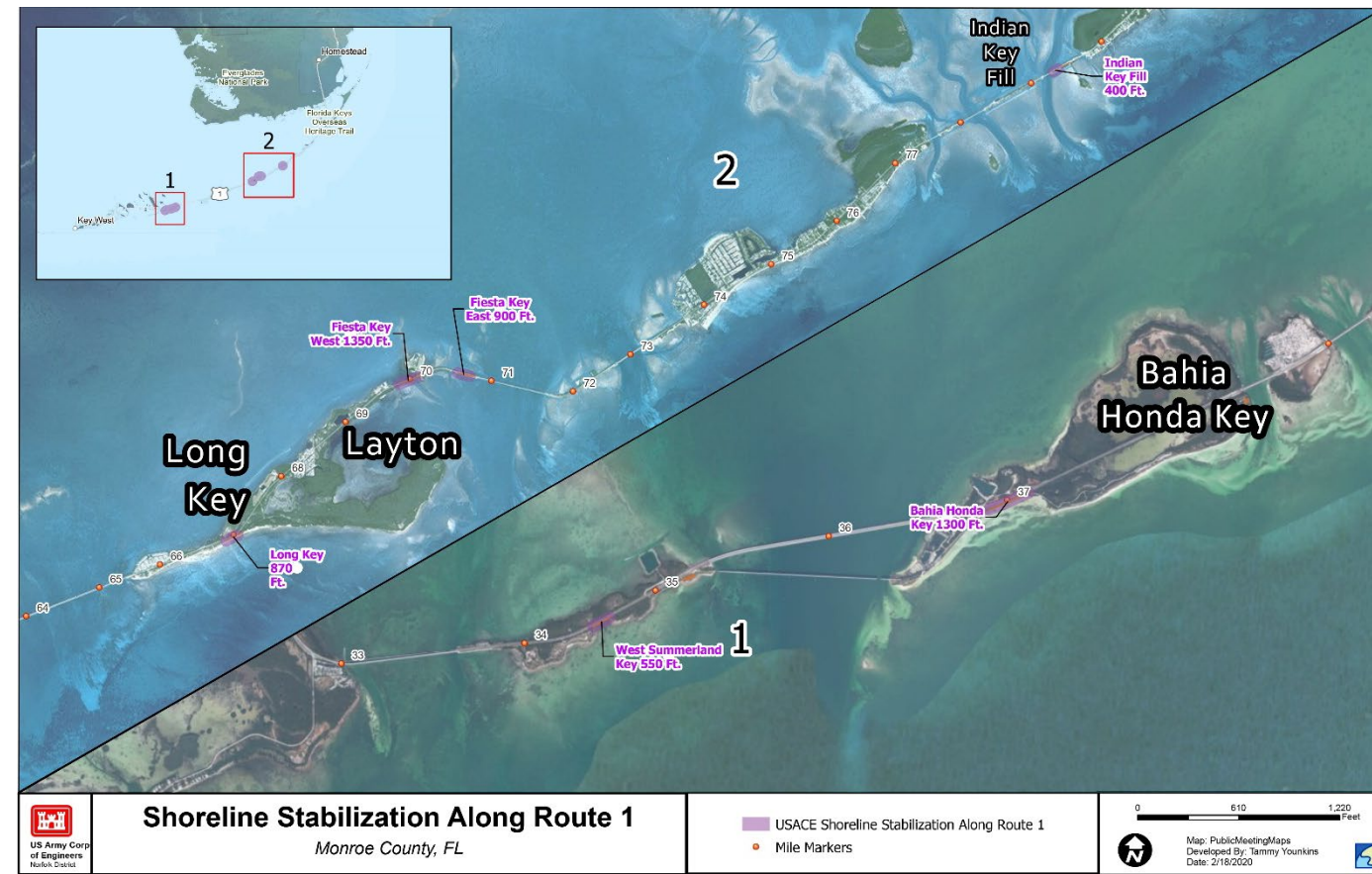
Dry Floodproofing

ARRAY OF ALTERNATIVES

An aerial photograph of a coastal area. A long, multi-lane bridge spans a body of water in the foreground. In the middle ground, there is a small island with a sandy beach, some buildings, and a parking lot. A boat is visible in the water, leaving a white wake. The water is a deep blue-green color, and the sky is a clear, bright blue.

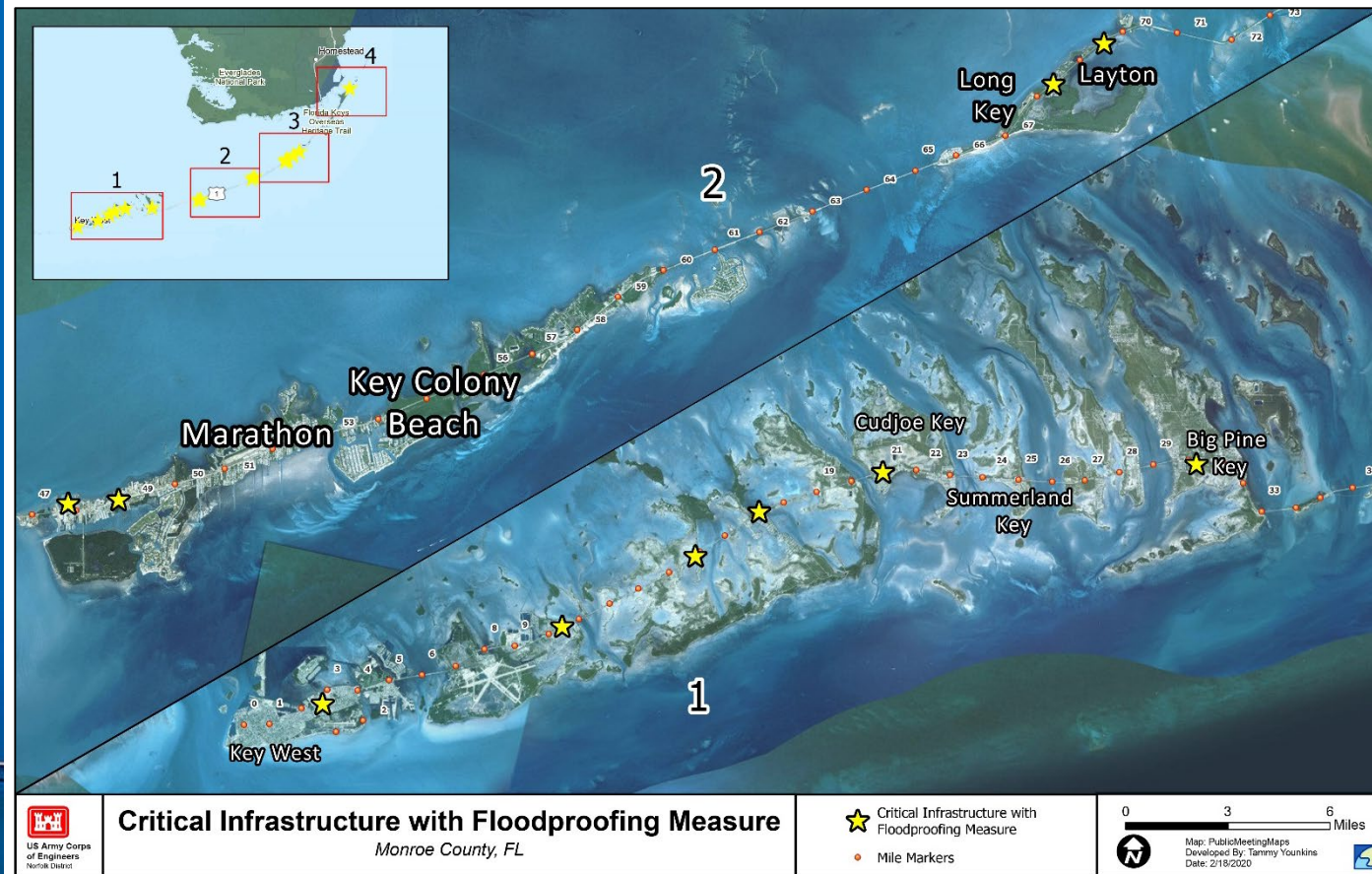
- ❑ After screening, the measures were combined into an array of alternatives.
- ❑ Three primary alternatives were developed.
- ❑ Those primary alternatives were then combined into larger alternatives, resulting in seven action alternatives that were evaluated.

ALTERNATIVE 1: U.S. 1



- Address 6 segments of US 1 identified as vulnerable to coastal storm damage
- Shoreline stabilization revetments to reduce erosion impacts on the roadway itself
- Shoreline stabilization and NNBF solutions will be economically justified primarily by reduction in damage to the roadway infrastructure itself

ALTERNATIVE 2: CRITICAL INFRASTRUCTURE*



Includes fire stations, medical facilities, police stations, potable water facilities, wastewater facilities, EOC facilities, and airport facilities. Floodproofing was identified as effective in reducing damage to critical infrastructure.

**This map only depicts half of the Keys as an example*

ALTERNATIVE 3: POPULATION/ DEVELOPMENT



Reduce storm damage to structures identified at risk by implementing one of the following measures based on structure type and risk:

Residential Nonstructural Measures

- Elevation
- Acquisition (Buyouts)

Non-Residential Nonstructural Measures

- Floodproofing

Other Nonstructural Measures

- Floodplain Management
- Warning Systems
- Emergency Planning



COMPARISON OF ALTERNATIVES

Alternative	Description	Average Annual Benefits (AAB)	Total Average Annual Cost (AAC)	Total Annual Net Benefit	BCR
1	U.S. 1	\$935,463	\$1,382,528	\$(447,065)	0.68
2	Critical Infrastructure	\$2,890,000	\$444,000	\$2,446,000	6.5
3	Population/ Development	\$211,810,000	\$113,528,216	\$98,281,784	1.9
4	U.S. 1 + Critical Infrastructure	\$3,825,463	\$1,826,528	\$1,998,935	2.1
5	U.S. 1 + Population/ Development	\$212,745,463	\$114,910,744	\$97,834,719	1.9
6	Critical Infrastructure + Population/ Development	\$214,700,000	\$113,972,216	\$100,727,784	1.9
7	U.S. 1 + Critical Infrastructure + Population/ Development	\$215,635,463	\$115,354,744	\$100,280,719	1.9
8	No Action	\$0	\$0	\$0	0.0

AAB – AAC = Total Annual Net Benefits (plan selection criteria)

TENTATIVELY SELECTED PLAN



ALTERNATIVE 7

- U.S. 1 shoreline stabilization (revetment) in 6 areas
- Nonstructural measures for all residential and non-residential structures at risk: elevation, acquisition, and floodproofing
- Floodproofing critical infrastructure at risk

ESTIMATED PROJECT COSTS*:

- First Cost (65/35): ~\$3,100,000,000
 - 65% federal funding of project = \$2,015,000,000
 - 35% non-federal funding of project = \$1,085,000,000
- Total Average Annual Benefit: ~\$215,635,000
- BCR is 1.9

* These numbers WILL continue to evolve as more detailed costs are developed.

REMAINING ANALYSIS TO BE COMPLETED FOR NONSTRUCTURAL MEASURES

An aerial photograph of a coastal area. In the foreground, a long, multi-lane bridge spans across the water. The water is a deep blue-green color. In the middle ground, there is a small island or peninsula with some buildings and trees. A few small boats are visible in the water. The background shows more of the coastline and the ocean.

- Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 incorporated
- FL State and County building code restrictions will be incorporated as appropriate
 - No floodproofing allowed in V zones
 - Mobile/manufactured homes cannot be elevated
 - Structure height limit, some exceptions available for elevation in municipalities
- Logical grouping of structures will be identified for elevation or acquisition per USACE PB 2019-03
- More thorough resilience analysis
- Sensitivity analysis for different design water levels and sea level change scenarios
- Participation rate analysis for elevation and floodproofing
- Refinement of costs

REMAINING ANALYSIS TO BE COMPLETED FOR U.S. 1

- **Evaluation of vehicle traffic benefits**
- **Evaluation of recreation benefits (if applicable)**
- **Incorporation of mangrove restoration as a natural and nature based feature (NNBF) if suitable in identified areas**



NEXT STEPS



Date	Task
May 2020	Briefing to Monroe BOCC for approval
Late May 2020	Draft Feasibility Report and Integrated EIS release
June 2020	Public meetings held in several locations throughout the Keys
May – July 2020	45 day review: public and agency, internal USACE technical and policy review, Independent External Peer Review (contract)
September 2020	Agency Decision Milestone
Spring 2021	USACE update back to Monroe BOCC
Spring 2021	Final Feasibility Report and Integrated EIS release
September 2021	Chief of Engineer's Report
Beyond 2021	Congressional authorization for construction; request for project appropriations; agreements with non-federal entities necessary for construction

QUESTIONS, COMMENTS & DISCUSSION

